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AUTHOR Furuto, David M.; Lang, Melvin
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ABSTRACT

The purpose of this investigation was to determine whether teaching strategies designed to help pupils build positive and realistic self concepts would have effects upon attitudes, anxiety, and achievement in mathematics. The population consisted of 60 students who had registered for a Survey of Mathematics course at Winward Community College during the 1979-1980 fall semester. These students were in two sections of the course, and one group was designated experimental, the other control. Four null hypotheses were generated for the study, and were rejected when data analysis revealed that subjects in the experimental group: (1) performed better; (2) developed more favorable attitudes; (3) had less anxiety; and (4) performed more commensurately with their mathematical ability than the control group. (MP)

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RELATIONSHIP OF SELF CONCEPT ENHANCEMENT TO ANXIETY AND ACHIEVEMENT IN COLLEGE MATHEMATICS

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by

David M. Furuto

WINDWARD COMMUNITY COLLEGE

and

Melvin Lang

UNIVERSITY OF HAWAII AT MANOA

Paper presented at the Annual Meeting of the American Educational Research Association, New York City, March, 1982

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INTRODUCTION

The educational system is primarily organized to produce persons who can deal with the words, concepts, and mathematical or scientific symbols so necessary for success in the technological society. But, the attitudes and values developed toward mathematics in students by the educational system are generally ignored. Nevertheless, the literature emphasizes that a persons affect and cognitions cannot be separated.

Each affective behavior has a cognitive counterpart, and each cognitive outcome causes an affective change. If one taught any concept, principle, or theory, then one taught not only for cognitive growth but also for affective change. For example, it would do little good to teach a student mathematics, if the student would end up disliking mathematics and would avoid mathematics whenever possible. Further, if a person wanted to be more aware about his feelings toward mathematics, then the person had to conceptualize his feelings and set his feelings in the context of his mathematics and life experiences, which meant that there was a cognitive component in experiencing a feeling.

The question then became: What other variables in addition to cognitive factors have an impact on learning, and how can the teacher use such variables to meliorate learning?

Are attitudes related to achievement? Neale (1969), Evans (1972), Mastantuono (1971), and Moore (1972) found that there is a significant, positive correlation when attitude scores are employed to predict mathematics achievement in the elementary schools. Further, Callahan (1971) and Taylor (1970) discovered that the late elementary and early junior-high grades are critical in the attitudinal development toward mathematics. So, there appears to be a dynamic interaction between attitude and achievement. Thus, elementary school teachers should be cognizant that a student's lack of success could be conducive toward a negative attitude toward mathematics. Consequently a vicious cycle may be started. Further, teachers of higher elementary school grades will have a more significant affect on attitudes toward mathematics.

Are there any sex differences in attitudes toward mathematics in the elementary schools? The answer seems to be a cautious no. Hilton and Berglund (1974) found sex differences in both attitudes and achievement in mathematics to favor boys over girls at the junior high level and above. However, socio-cultural expectations and sex role models should also be taken into consideration; and this accounts for the weak no.

What personality variables relate to attitude and achievement in mathematics in the elementary schools? Naylor and Gaudry (1973) and Swafford (1970) found that attitude and achievement in mathematics are significantly related to personality variables that indicate good adjustment, such as a greater sense

of responsibility, high personal worth, high social standards, high motivation for academic achievement, and more freedom from withdrawing tendencies. Aiken (1972) learned that children who had a positive attitude to mathematics had a proclivity for detailed work and viewed themselves as more persevering and self-confident. Neale (1969) and Weston (1969) reported that children who perform mathematics well are more conforming and obedient and have more possessive parents. Aiken (1972) and Burbank (1970) stated that there is a positive correlation between the student's attitude and achievement in mathematics and parental attitudes. May (1972) found that elementary school children who do well in mathematics are more intuitive in their thinking. Finally, Trown (1970) found that introverts performed better when rules were presented before examples, whereas extroverts were superior when rules were given after examples. Personality variables proliferate the teaching and learning environment, and the wise teacher would do well to become acquainted with them to provide more effective instruction.

Do teacher attitudes toward mathematics vary with respect to level? Early (1970) learned that with respect to subject and grade level, prospective secondary math teachers have a more positive attitude to mathematics than elementary school teachers, and grades 4 - 6 teachers more positive than grades K - 3 teachers.

Do teachers' attitudes to mathematics affect students' attitudes to mathematics? The answer is a careful yes. Although Van de Walle (1973) found no statistically significant

relation between teacher attitudes and either attitudes or changes in attitudes of their pupils, Phillips (1973) found that the type of teacher attitude for two out of the past three years, and expecially most recent teacher attitude to be significantly related. Hopefully, the relatively contradictory findings will engender further studies to resolve the question.

Do calculators, computers, machines, and physical materials improve attitudes toward mathematics? Conflicting findings leave this question unanswered.

Do innovative approaches to instruction such as experimental, student-centered, and discovery produce greater achievement and positive attitudes than a teacher-centered, expository, traditional approach? The answer tends to be that there are no statistically significant differences (Demars, 1972; Joyner, 1974; Williams, 1974; Struder, 1972; Malcolm, 1973; Scharf, 1971; Corbin, 1974; Ronshausen, 1972)

Do behavior modification techniques improve attitudes to mathematics? The answer is yes. Robbins (1973) utilized both verbal and physical reinforcements with third graders to gain attitudinal improvements to mathematics. Further, Dil and Gotts (1971) also used with elementary school children similar techniques to report positive changes in arithmetic self-concept.

Purpose

The purpose of this study was to determine whether teaching strategies which were designed to help the student build a positive and realistic self concept would have an effect upon a student's attitudes and anxiety toward mathematics and a student's achievement in mathematics. This study was done with students at a two year college who had registered for a mathematics course which fulfilled a quantitative and logical reasoning requirement.

Hypotheses

The following hypotheses were formed.

1. There will be no significant difference between the mathematics anxiety of the control group and the mathematics anxiety of the experimental group.

2. There will be no significant difference between the mathematics achievement of the control group and the mathematics achievement of the experimental group.

3. There will be no significant difference between the mathematics attitude of the control group and the mathematics attitude of the experimental group.

4. There will be no significant difference between the coefficient of correlation for the relationship between mathematics ability and mathematics achievement in the experimental group and the coefficient of correlation for the relationship between mathematics ability and mathematics achievement in the control group.

Definition Of Terms

Mathematics 100 was a survey of mathematics course within the University of Hawaii System that was primarily designed for the non-mathematics and non-science major and which fulfilled a quantitative and logical reasoning requirement within the general education core requirements.

Mathematics ability was defined by the subject's score on the Applied Arithmetic and Elementary Algebra Test that was designed by the Educational Testing Service and the College Entrance Examination Board.

Mathematics achievement was defined by the subject's grade for the Mathematics 100 course.

Mathematics anxiety was defined as feelings of tension and anxiety that interfered with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

Mathematics attitude was defined to be approximately the same as enjoyment, interest, and to some degree, level of anxiety.

Method

To test the hypotheses, the following subjects, materials, and procedures were used.

Subjects

The population to be sampled was comprised of students who had registered for Mathematics 100, Survey of Mathematics, at Windward Community College during the Fall Semester of the 1979-80 Academic Year. The sample included approximately 60 students who had registered for two sections of Mathematics 100, Survey of Mathematics.

Materials and Instruments

To determine each subject's mathematics ability at the entry level for Math 100, the Applied Arithmetic and the Elementary Algebra Test, which was designed by Educational Testing Service and College Entrance Examination Board, was used.

The Mathematics Anxiety Rating Scale, which was designed by R. M. Suinn and others and is a ninety-eight item inventory of situations that might arouse mathematics anxiety, was used to assess math anxiety.

The Mathematics Attitude Scale, which was designed by Lewis R. Aiken, Jr. et al and is a Likert-type scale, was used to evaluate math attitude.

Both the Mathematics Anxiety Rating Scale and the Mathematics Attitude Scale were developed for use with colleges and have fairly promising reliability and validity factors.

Mathematics 100, Survey of Mathematics, was designed to satisfy a quantitative and logical reasoning requirement. Math 100 encompassed topics such as sets, logic, algebra, probability, and statistics.

Strategies for the development of self concept that were used in this experiment were essentially predicated on helping the student to derive a positive self-evaluation. It was assumed that self-evaluation was basically the product of how one thinks that the significant other persons in his life perceives him and relates to him. It was assumed that one would build a theory of personal existence through experiencing interactions with significant others. In addition, this writer corroborated with other educators to develop activities for building self concept in mathematics.

Examinations for Math 100 were designed by the mathematics faculty at Windward Community College and were used to determine mathematics achievement. Criterion-referenced rather than norm-referenced grading was used.

Procedures

The following procedures were employed in this experiment.

Data Collection

The time frame for data collection for this experiment was during Fall Semester of 1979-80.

The population to be sampled encompassed students who had registered for Math 100, Survey of Mathematics, at Windward Community College. Within the population, two groups, one experimental and one control, were identified. The experimental group was taught by one instructor, and the control which was another separate section was taught by a different instructor.

In both the control and the experimental sections, the teachers clearly explained what the student would be expected to do to successfully complete the course, and what the student could expect to learn through successful completion of the course. Further, both the control group and the experimental group subjects were graded by a criterion-referenced evaluation system.

Subjects in both the control and experimental groups were primarily taught during the regular class meeting through the conventional lecture-discussion-demonstration instructional mode. Basically, the instructors used

each class meeting: to review homework, to present new material, to demonstrate examples and applications, and to assign homework.

Essentially, the difference between the control and the experimental groups existed in the visits or interviews with the instructor outside of the regular class meeting. In the control group, although the student could visit with the instructor for any reason during the instructor's regular office hours, the student was not encouraged or required to visit the instructor.

In the experimental group, each subject was required to meet with the instructor for approximately fifteen minutes during each week of the semester. During the weekly interviews, the instructor predicated the interaction upon self concept building processes. A major purpose of the weekly meetings was to convey to the student that the teacher had a positive perception of the subject as an able, valuable, and self-directing learner. A major function of the teacher was to listen with care which is the process whereby the teacher works to understand what is occurring inside the perceptual world of the student where the student receives, interprets, and acts upon any communication. Another of the teacher's functions was to be real, genuine, or authentic.

The following Self Concept Building Record delineates a check list and responsibilities of the instructor of the experimental group. The instructor kept inventory of the frequency and degree of the activities, where appropriate.

Self Concept Building Inventory

Before The Interview

The teacher found out through the student biographical survey:

What are the student's educational goals?

Why is the student taking the course?

What is the student's math background and competency?

Does the student work; and if so, what is the student's work?

What are the student's interests, hobbies, and recreational activities?

What is the student's academic schedule for the semester?

What other time commitments does the student have?

The student was requested but not required to fill out the student biographical survey.

The teacher ascertained whether the student knew what the student would be expected to do to successfully complete the course, and what the student could expect to learn from the course after the successful completion of the course.

During The Interview

The teacher warmly welcomed and showed appreciation of the student.

The teacher asked how the student was doing and inquired about any major occurrences in the student's life.

The student showed written work which the instructor felt was conducive to building self concept and responsibility, such as: the student's math homework, the student's class notes, the student's feelings about the value of mathematics in the student's life or future, the student's feelings about the degree of enjoyment from mathematics, the student's feelings about the degree of dislike or fear of mathematics and about why the dislike or fear exists, and/or other assignments which may have been given during an earlier interview.

The teacher asked whether the student had any questions about the material which was covered during regular class meetings.

The teacher encouraged the student to express ideas and personal experiences, and made the student feel that what the student said was important.

The teacher did not underestimate or overestimate the student's potential and capability, but realistically expected the student to perform at a level which was commensurate with the student's potential.

The teacher sincerely praised the student when the student performed at a level which was commensurate with the student's potential.

The teacher described math applications which were relevant to the student's interests and goals.

The teacher provided challenges and/or goals, through assignments and problems that were either worked by the student during the interview or done by the student before the next interview, which the student could do with a high probability of success.

The teacher made positive comments, both written and oral, on the student's work.

The teacher shared personal experiences that were chosen to help build confidence in the student.

The teacher encouraged a sense of humor.

The teacher used the name of the student as frequently as possible but without overdoing it.

The teacher made the student feel that the student should not blame anyone if something goes wrong, that the student was in control for the degree of success, and that ultimately the student was to be responsible for the student's learning.

Following The Interview

The student was to complete any work that was assigned during the interview and to report during a future interview.

The student was to teach at least one mathematical concept to another person and to report during a future interview.

The student was to relate at least one math concept from the course to an example in the student's environment and to report during a future interview.

Research Design

To test the hypotheses in this experiment, a preexperimental design, the static-group comparison, and a quasi-experimental design, the nonequivalent-control-group design, as described in the reference, Experimental and Quasi-experimental Designs For Research by Donald T. Campbell and Julian C. Stanley, were used.

In the symbolic representation of Campbell and Stanley, the design was expressed as:

$O_1 \quad O_2 \quad O_3 \quad X \quad O_4 \quad O_5 \quad O_6$

$O_1 \quad O_2 \quad O_3 \qquad O_4 \quad O_5 \quad O_6$

where O_1 represents the Applied Arithmetic and Elementary Algebra Test; O_2 and O_4 represent the Mathematics Anxiety Rating Scale; O_3 and O_5 represent the Mathematics Attitude Scale; and O_6 represents the posttest (examinations).

Factors which jeopardize the internal and external validity of this research design are discussed by Campbell and Stanley. Greater emphasis was placed upon the independent or treatment variable X, or internal validity.

Results

Pretest administration of the Applied Arithmetic and Elementary Algebra Test by Educational Testing Service and College Entrance Examination Board, the Mathematics Anxiety Rating Scale (MARS), and the Mathematics Attitude Scale (MAS) revealed fairly equivalent experimental and control groups, which was determined by a t-test to compare whether the mean scores of the two groups were significantly different. Table 1 below did not show any significant differences for the measures.

Table 1

Pretest Scores

	Experimental Group		Control Group			
	Mean	Standard Deviation	Mean	Standard Deviation	t	p
ETS-CEEB	66.5	11.5	66.1	11.9	0.4	NS
MARS	235.7	51.3	231.6	52.4	0.31	NS
MAS	57.9	10.9	59.1	11.3	0.58	NS

In Table 2, the mean score of the experimental group on the Mathematics Anxiety Rating Scale (MARS) was found to be significantly different at the .05 confidence level from the mean score of the control group. Consequently, hypothesis one was rejected.

Table 2

Posttest Scores

	Experimental Group		Control Group			
	Mean	Standard Deviation	Mean	Standard Deviation	t	p
Achievement	78.9	8.3	71.4	9.6	7.66	.01
MARS	182.3	55.6	221.7	53.1	-2.32	.05
MAS	65.7	10.1	60.1	11.1	1.70	.10

Further, Table 2 above indicated that there was a significant difference at the .01 level between the mean score of the mathematics achievement for the experimental group and the mean score for the control group. Thus, hypothesis two was also rejected.

In addition, the mean score of the experimental group on the Mathematics Attitude Scale (MAS) was found to be significantly different at the .10 confidence level from the mean score of the control group. Hence, hypothesis three was not accepted.

The Pearson product-moment correlation was used to determine the relationship between the students' performance on the Applied Arithmetic and Elementary Algebra Test by Educational Testing Service and College Entrance Examination Board and their Final Grades for the course. In the experimental group the correlation coefficient was 0.81; and in the control group, the correlation coefficient was 0.72. The Fisher z score was 2.15 which showed that there was significant difference between the two correlation coefficients for the experimental and control groups at the .05 confidence level. Therefore, hypothesis four was rejected.

Discussion

In testing hypothesis one, the lower mean of the experimental group suggested that the experimental group had significantly less mathematics anxiety than the control group.

In the test for hypothesis two, the higher mean in mathematics achievement for the experimental group implied that the experimental group performed significantly better in mathematics than the control group.

In the analysis of hypothesis three, the higher mean on the Mathematics Attitude Scale by the experimental group was construed as the experimental group developed a more favorable attitude toward mathematics than the control group.

Hypothesis four test results inferred that subjects in the experimental group performed more commensurately with their mathematics ability than the subjects in the control group.

The building self concept approach in mathematics, as described and employed within this experiment, seemed to have a significant effect on developing favorable attitudes toward mathematics, on alleviating mathematics anxiety, and increasing mathematics achievement. These findings seem to have import, especially when one analyzes the affective domain in context. Feelings and emotions have probably been developed over a considerable time frame throughout each subject's life time, and the experimental time period was

approximately four months.

It is recommended that follow-up studies be conducted with the experimental and control groups to determine: 1. whether further mathematics courses are taken; and 2. what type of success do the two groups experience in future mathematics courses and in classroom teaching experiences. In addition, since the interviews served a critical function in helping to build self concept, a study should be done to determine the optimum interview time and the frequency of the interviews.

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